APPENDIX II: MATRICES OF HABITAT CHARACTERISTICS AND PARAMETERS

When developing a restoration monitoring plan, the goals of the project and knowledge of the habitat should be used to identify potential structural and functional characteristics to be monitored. Parameters then need to be identified that can be used to appropriately determine the status of or change in each characteristic.

In some cases, it is critical to monitor the effects a restoration project has on social or economic aspects of the local human community or regional population. The parameters presented in this appendix and elsewhere in this volume, however, do not address socioeconomics. The monitoring of the effects of coastal restoration on human dimensions will be covered in *Volume Two: Tools for Monitoring Coastal Habitats*. Additionally, a stand-alone document addressing in detail the role of socioeconomics in the monitoring of coastal restoration projects is currently in development.

Through a series of matrices, this appendix establishes a three-part process that walks the reader through the selection of habitat characteristics and corresponding parameters for inclusion in a restoration monitoring plan. The three steps are: identification of appropriate structural and functional characteristics of the habitat; identification of parameters that determine the change in or status of those habitat characteristics; and determination of suitability of the potential parameters for use in a given habitat. An example of how to use this appendix follows the description of the matrices

In using these matrices, it should be remembered that the goal of coastal restoration is to recover functioning habitat as noted earlier in this document in *The Process of Developing a Monitoring Plan*.

Matrix A. Structural and Functional Characteristics of the Habitats

The structural components of a habitat are the physical, chemical, and biological characteristics that define that habitat. The functional components are the processes occurring within and between habitats as a result of their structural components. The ultimate goal of any restoration action should be to return functions and not simply build structure⁶. Understanding the structure and function of a habitat allows for an understanding of the fundamental ecology of the system and selection of those parameters most relevant to the goals of the project.

Matrix A provides a listing of significant structural and functional characteristics for each habitat type. This listing was developed through searches of the ecological literature, published restoration efforts, and ecological monitoring studies. Additionally, ecologists, restoration researchers, and people involved with monitoring provided extensive input. Other characteristics not included on these lists may be appropriate depending on the goals of an individual restoration project. The determination of which structural and functional characteristics will be monitored for a given restoration project should be made in conjunction with experts on the local habitat, keeping in mind that the goals of a given project that directly determines the characteristics to be monitored.

Detailed habitat descriptions, as well as discussions of the habitat structural and functional characteristics and the rationale for their inclusion, are found in *Coastal Habitats: Ecology, Restoration, and Monitoring*, a chapter in *Volume Two: Tools for Monitoring Coastal Habitats*.

Matrix B. Structural and Functional Characteristics and Their Associated Parameters

Once a list of the relevant structural and functional characteristics to be monitored has been developed for a restoration project, parameters need to be identified that will appropriately determine the status of or change in those characteristics.

Matrix B provides a list of parameters associated with each structural and functional characteristic identified in Matrix A. The experts in each habitat reviewed and augmented the lists to ensure that parameters included can be used to accurately assess progress toward restoration goals. Additionally, searches of the ecological literature, published restoration efforts, and ecological monitoring studies were conducted to determine the types of parameters considered in coastal restoration projects. Matrix B should be used to develop a broad list of potential parameters that may be included in the monitoring plan. This list of potential parameters is not exhaustive, however, and should be considered a starting point. Other parameters not included on these lists may be appropriate for assessing change in or the status of a given characteristic. The determination of the parameters to be monitored should be made in conjunction with experts, including those with a background in statistics, the local habitat, and monitoring the characteristics in question.

Matrix C. Restoration Monitoring Parameters By Habitat

Once a broad list of monitoring parameters has been developed, it is important to review that list to determine those parameters that are applicable to a specific habitat. Matrix C provides a list of parameters that are significant or appropriate for monitoring in each habitat. The parameters have been sorted to reflect their relevance to either structural or functional characteristics.

As with Matrices B and C, the listing of habitat specific parameters used in restoration monitoring was developed through literature searches of restoration efforts and ecological monitoring studies and through extensive input from restoration and monitoring researchers with expertise in that particular habitat. The lists include those parameters most commonly measured in restoration monitoring in each habitat and are not to be considered exhaustive. Experts on each habitat have reviewed and augmented the lists to ensure that parameters included can be used to accurately assess progress toward restoration goals. Other parameters not included on these lists may be appropriate depending on the goals of an individual restoration project.

The parameters included in this matrix are classified into two groups. Parameters marked with a filled circle are those indicated by experts as critical for inclusion in the monitoring of most restoration projects in this habitat. Parameters marked by an open circle are those that may be considered for inclusion in a monitoring plan, depending on the goals of the restoration project but are not considered critical for all monitoring projects.

How to Use the Matrices

The example provided below walks readers through the process of identifying potential parameters to be measured in the monitoring of a coastal restoration project. Although most projects will have multiple goals, this example will pertain to a single goal.

Project goal: To increase the acreage of marsh habitat within the project area as a means of supporting an endangered terrapin population.

Matrix A: There are a wide variety of structural and functional characteristics associated with marshes. When reading through this list, the intent and constituent parts of the specific goal should be kept in mind. Given that the goal above involves creating marsh with the specific idea of supporting terrapins, the long list of characteristics can be reduced to these items:

- Habitat created by plants
- Provides breeding grounds
- Provides nursery area
- Provides feeding grounds
- Supports a complex trophic structure
- Supports biomass production

Matrix B: For each characteristic identified in Matrix A, a set of potential parameters is then identified. This example walks through the parameter selection process for one of the characteristics from the above list. The long list of parameters generated in this step of the process will be tailored to the habitat in question through the use of Matrix C and knowledge of the intent of the specific goal.

Parameters associated with the functional characteristic "Provides feeding grounds":

Geographical

• Acreage of habitat types

Biological

Plants

- Species, composition, and % cover of:
 - o Algae
 - o Epiphytes
 - o Herbaceous vascular
 - o Invasives
 - o Woody
- Canopy extent and structure
- Interspersion of habitat types
- Litter fall
- Mast/seed production
- Phytoplankton diversity and abundance
- Plant health (herbivory damage, disease)
- Plant weight (above and/or below ground parts)
- Woody debris (root masses, stumps, logs)

Animals

- Species, composition, and abundance of:
 - o Amphibians
 - o Birds
 - o Fish
 - o Invasives
 - o Invertebrates

- o Mammals
- o Reptiles
- Coral growth rate
- Coral recruitment and survivorship
- Vertical relief of reef

Hydrological

Physical

- Trash
- Water level fluctuation over time

Chemical

- Chlorophyll concentration
- Salinity (in tidal areas)
- Toxics

Soil/Sediment

Physical

- Basin elevations
- Geomorphology (slope, basin cross section)

Chemical

• Organic content in sediment

Matrix C: This matrix assists readers in reducing the long list of potential parameters down to those appropriate for the habitat and goal in question.

Using Matrix C and knowledge of terrapin biology, the list of parameters for the functional characteristic "provides feeding grounds" becomes:

- Acreage of habitat types (associated with the structural element of the goal)
- Interspersion of habitat types (allows access to marsh habitat)
- Herbaceous species composition and percent cover (type and density of marsh plants is one aspect of the quality of the habitat)
- Species composition and abundance of:
 - o Fish (potential prey items)
 - o Invertebrates (potential prev items)
 - o Reptiles (terrapins)
- Water fluctuation over time (important for marsh health, as well as aspects of terrapin biology including breeding and feeding)
- Basin elevations (important aspect of habitat quality and accessibility)
- Geomorphology, including slope and cross section (important for marsh diversity and accessibility)

This process provides a convenient means of identifying habitat characteristics and their associated parameters. It is critical, however, that the process be augmented with a thorough knowledge of local habitats and a strong understanding of the intent of the project goals. Use the characteristics and parameters identified through the use of these matrices as a starting point for discussion for a group that includes managers, statisticians, and scientists such as ecologists, hydrologists, geologists, physical oceanographers, and fisheries biologists.

Matrix A: Structural and Functional Characteristics of the Habitats

						На	bita	ts					
Structural Characteristics	Water Column	Rock Bottom	Coral Reef	Oyster Reef	Soft Bottom	Kelp and Macroalgae	Rocky Shore	Soft Shore	SAV	Marsh	Mangroves	Deepwater Swamps	Riverine Forests
Biological													
Habitat created by animals			Х	Х									
Habitat created by plants ¹						Х			Х	Х	Х	Х	Х
Physical													
Sediment grain size		Х		Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Topography/Bathymetry		Х	Х	Х	Х		Х	Х	Х	Х	Х	Х	Х
Turbidity	Х					Х			Х				
Hydrological													
Current velocity	Х	Х		Х	Х	Х	Х		Х	Х	Х	Х	
Tides/Hydroperiod ²	Х			Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Water sources	Х	Х	Х	Х	Х	Х			Х	Х	Х	Х	Х
Wave energy	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х		
Chemical													
Nutrient concentration	Х		Х	Х					Х	Х	Х		
pH, salinity, toxics, redox, DO	X	Х	X	X	Х	Х	х		X	X	X	х	Х
Biological Contributes to primary productivity Exhibits symbiotic species interactions	Х		X			Х		Х	Х	Х	Х	Х	Х
Produces wood											Х	х	х
Provides breeding grounds	х	Х	Х	Х	Х	Х	х	Х	Х	Х	Х	X	Х
Provides feeding grounds	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
Provides nursery areas		Х	Х	Х		Х			Х	Х	Х	Х	Х
Provides refuge from predation		Х	Х	Х		Х	Х	Х	Х	Х	Х		
Provides substrate for attachment		Х	Х	Х		Х	Х		Х	Х	Х		
Supports a complex trophic structure			Х	Х		Х			Х	Х	Х	Х	Х
Supports biodiversity			Х	Х		Х			Х	Х	Х		
Supports biomass production	Х		Х	Х		Х			Х	Х	Х	Х	Х
Hydrological Physical													
Affects transport of suspended/dissolved material	Х	Х							Х	Х	Х	Х	Х
Alters turbidity		Х		Х	Х			Х	Х	Х	Х	Х	Х
Modifies water temperature									Х		Х	Х	Х
Provides temporary flood water storage			1			1				Х	Х	Х	Х
Reduces erosion potential		X	X	X		X	X		X	X	X	Х	
Reduces wave energy		Х	Х	Х	<u> </u>	Х	Х	<u> </u>	Х	Х	Х		<u> </u>
Chemical													
Modifies chemical water quality	Х			Х	Х	Х			Х	Х		Х	Х
Modifies dissolved oxygen					X	X			X				
Supports nutrient cycling	X		Х	Х	Х	Х			Х	Х	Х	Х	Х

When present, plants are always important even if they are not a defining structural feature of the habitat.
 Refers to the timing, height, and duration of water level fluctuations
 X = a defining structural or functional characteristic of a particular habitat

Matrix B: Parameters to Monitor Structural and Functional Characteristics

pH, salinity, toxics, redox DO																								
Nutrient concentration											*													
Chemical																								
Wave energy																						•		
Water Sources																								
Tides Hydroperiod																								
Current velocity																						*	•	
Hydrological				•												•	•		•					
Turbidity	•										*								*	*	*			
Topography Bathymetry										•					•		•							
Sediment grain size																								
Physical																								
Habitat created by plants	•			*	*	*	*	*	*	•	*	*	*	•	•									
Habitat created by animals	•									•							•							
Biological				•												•	-		•					
Parameters to Monitor	Geographical Acreage of habitat types	Biological Plants	Species, composition, and % cover of:	Algae	Epiphytes	Herbaceous vascular	Woody	Basal area	Canopy extent and structure ²	Interspersion of habitat types	Phytoplankton diversity and abundance	Plant height	Seedling survival	Stem density	Woody debris (root masses, stumps, logs)	Animals	Vertical relief	Hydrological Physical	Chlorophyll concentration	PAR³	Secchi disc depth	Shear force at sediment surface	Sheet flow	
	Montrient Chemical Fiological Fiological Fiological Fiological Fiological Fiological Formital Formital Formital Forment yelocity Formical Forment yelocity Formical Formical	## Topography Physical Phydroperiod Phyd	Parameters to Monitor Biological Habitat created by Plantiat created by Plantiat Concentration Physical Current velocity Hydroperiod Water Sources Wave energy Tides Wave energy Wave energy Chemical Chemical Chemical Chemical Chemical Chemical Chemical	omposition, and % concentration of habitat types of habitat types omposition, and % cover of the concentration omposition, and % cover of the	Parameters to Monitor Biological Biological Habitat created by Bathymetry Physical Tides Physical Topography Physical Tides Hydroperiod Wave energy Current velocity Hydroperiod Wave energy Water Sources Wave energy Cal Wave energy Water Sources Wave energy Chemical Outrient Concentration Physical Wave energy Water Sources Wave energy Chemical Outrient Outrient Concentration Physical Wave energy Chemical	Biological Habitat created by animals Habitat created by plants Habitat created by plants Physical Topography Bathymetry Turbidity Hydroperiod Wave energy Turbidity Hydroperiod Water Sources Wave energy Mater Sources Wave energy Mutrient Concentration Physical Wave energy Mutrient Concentration Physical Mutrient Concentration	Parameters to Monitor Biological Biological Habitat created by animals Physical Current velocity Physical Tides Hydroperiod Wave energy Tides Hydroperiod Wave energy Water Sources Wave energy Chemical Chemical Hutrient Concentration Physical Wave energy Chemical Mutrient Concentration Physical Mutrient Concentration Physical Mutrient Concentration	Biological Biological Biological Biological Biological Habitat created by Bathymetry Parameters to Monitor Biological Habitat created by Bathymetry Tides Hydroperiod Wave energy	Parameters to Monitor Biological Biological Habitat created by Habitat types Addroperiod Tides Hydroperiod Wave energy Chemical Wave energy Water Sources Wave energy Water Sources Wave energy Water Sources Wave energy Chamical Wave energy Concentration Physical Wave energy Water Sources Worker Water Sources Worker Water Sources Wave energy Concentration	Parameters to Monitor Parameters to Monitor Parameters to Monitor Biological Habitat created by Physical Current velocity Hydroperiod Wave energy Chemical Chemical Concentration Hydroperiod Wave energy Chemical Hydroperiod Wave energy Chemical Hydroperiod Wave energy Chemical Duttient voxica:	Parameters to Monitor Parameters to Monitor Biological Habitat created by animals Habitat created by Physical Current velocity Habitat created by Physical Current velocity Habitat created by Physical Current velocity Wave energy Chemical Chemical Physical Wave energy Chemical Physical Wave energy Wave energy Chemical Physical Wave energy Chemical Physical Chemical Physical Wave energy Chemical Physical Chemical Chemical Chemical Physical Chemical Chemical Chemical Chemical Chemical Chemical Chemical Chemical Chemical Chemical	Parameters to Monitor Parameters to Monitor Parameters to Monitor Parameters to Monitor Biological Gediment grain size Physical Hydroperiod Wave energy Turbidity, toxics, Physical Physical Physical Physical Wave energy Wave energy Turbidity Wave energy Physical Ph	Parameters to Monitor Biological Biological Habitat created by Bathymetry Physical Habitat created by Bathymetry Physical Turbidity Physical Habitat types Turbidity Physical Wave energy Cal Hydroperiod Wave energy Chemical Oody I area Physical Wave energy Chemical Oody I area Physical Wave energy Chemical Oody I area Physical Wave energy Chemical Oody I area Physical Wave energy Chemical Oody I area Physical Wave energy Chemical Oody I area Physical Wave energy Chemical Oody I area Physical Wave energy Chemical Oody I area Physical Wave energy Chemical Oody I area Physical Wave energy Chemical	Parameters to Monitor Biological Biological Ged of habitat types Figure of 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Biological Graf life survival life survival concentration Calculating survival life survival life survival life survival concentration Calculating survival life surviva	Parameters to Monitor Parameters to Monitor Phiesi Biological Habitat created by Authoreful and Scower of animals Habitat (realed by Hadron diversity and abundance in fine string) Physical animals Bensoon of habitat types Physical animals Physical animals Habitat (realed by Hadron diversity and abundance in fine string) Physical animals Physical animals Hadron of the selection of habitat types Physical animals Physical animals Bensoon of habitat types Physical animals Physical animals transfers Physical animal	Parameters to Monitor Parameters to Monitor Parameters to Monitor See of habitat types Biological Hydrological Fies, composition, and % cover of, the abitat types Physical Biological Hydrological Hydrological Fies can be seed of habitat types Physical Biological Hydrological Hydro	Parameters to Monitor Parameters to Monitor Parameters to Monitor

¹ Dissolved oxygen ² Applies to forest, submerged aquatic vegetation (SAV), and kelp habitats ³ Photosynthetically active radiation, measured at canopy height and substrate surface

= a pairing between a habitat characteristic and a measured parameter

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

	redox, DO]											1															
	pH, salinity, toxics,								*			•	•		*												•	•
	Nutrient concentration										*			•								•	*	•		*		
•	Chemical	ı					<u> </u>						<u> </u>						<u> </u>			<u> </u>	<u> </u>					
	Wave energy																											
S	Water Sources			*	*		•			*			•		•													
Structural Characteristics	Fides Hydroperiod		*	*			•						•						*	•	*	*		*				
acte	Current velocity					*																		*				
Shar	Hydrological	J			l <u> </u>	l																l	<u>I</u>					
ıra	Turbidity																											
uctu	Тородгарһу Ваtһутеtгу																*			•				*				
Str	Sediment grain size																	•				*	*	*				
•	Physical												•															
•	Habitat created by																											
-	Habitat created by animals																											
•	Biological	1					II						l									l						
	Parameters to Monitor	Hydrological (cont.) Physical (cont.)	Temporary water	Temperature	Upstream land use	Water column current velocity	Water level fluctuation over time	Chemical	Dissolved oxvaen	Groundwater indicator chemicals ⁴	Nitrogen and phosphorus	Hd	Salinity (in tidal areas)	Silicon	Toxics	Soil/Sediment Physical	. Basin elevations	Bulk density	Depth of mottling	Geomorphology (slope, basin cross section)	Moisture levels and drainage	Organic content	Percent sand, silt, and clay	Sedimentation rate and quality	Chemical	Pore water nitrogen and phosphorus	Pore water salinity (in tidal areas)	Redox potential

⁴ Calcium and magnesium

igl = a pairing between a habitat characteristic and a measured parameter

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

= a pairing between a habitat characteristic and a measured parameter

⁵ Applies to forest, submerged aquatic vegetation, and kelp habitats ⁶ If the whole community is destroyed by disease or lack of seedling survival, all vegetation-related functions will be impaired

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

Supports nutrient cycling																			
Modifies dissolved oxygen																	•		
Modifies chemical water quality																	•		
Chemical	•																		
Reduces wave energy			•	•															•
Reduces erosion potential		*	*	•															•
Provides temporary floodwater storage																			
Modifies water temperature			•																
Alters turbidity			•								*				*	*			•
Affects transport of suspended/dissolved material			*								•				*	*			•
РһуѕісаІ		-																	
Supports biodiversity				•				*	*	*	•	•	*	•	*				
Supports biomass production								*	*	*	•	*	*	*	*				
Supports a complex trophic structure			*	•				*	*	*		*	*	*	*	•			•
Provides substrate for attachment	:		*	•											*	•			•
Provides refuge from predation			•	•				•	*	•	•	•	•	•	*	•		•	•
Provides nursery areas			*	•				*	*	*	*	•	*	*	*	*		•	•
Provides feeding grounds				•				*	*	*	*	*	*	•	*	•			•
Provides breeding grounds				•				*	*	*		•	*	*	*	•			•
Produces wood		*		•															
Exhibits symbiotic species interactions															*	*			
Contributes primary production															*	*		•	•
Biological	•						ij												
Parameters to Monitor	Biological (cont.) Plants (cont.)	Seedling survival ⁷	Stem density	Woody debris (root masses, stumps, logs)	Biological	Animals	Species, composition, and abundance of:	Amphibians	Birds	Fish	Invasives	Invertebrates	Mammals	Reptiles	Coral growth rate	Coral recruitment and survivorship	Fecal coliforms	Grazer density	Vertical relief of reef
	Biological Contributes primary production Exhibits symbiotic species interactions Provides wood Provides freeding grounds Provides refuge from predation Provides refuge from predation Provides unrsery areas Provides unsery areas Supports a complex trophic subports a complex trophic subports biomass production Supports a complex trophic	ameters to Monitors Biological Contributes primary production interactions Exhibits symbiotic species interactions Provides breeding grounds Provides breeding grounds Provides refuge from predation Provides refuge from predation Provides aubstrate for attachment Supports a complex trophic structure Supports a complex trophic subports biodiversity Affects transport of Supports biodiversity Supports biodiversity Supports biodiversity Affects transport of Supports biodiversity Supports a complex trophic subports biodiversity Supports biodiversity Affects transport of Supports biodiversity Supports biodiversity Supports biodiversity Supports biodiversity Supports biodiversity Supports biodiversity Chemical Chemical	Biological Contributes primary production interactions Exhibite symbiotic species interactions	Biological Contributes primary production provides breeding grounds provides refuge from predation provides removed material provides p	Biological Contributes primary production Exhibits symbiotic species interactions	Biological Contributes primary production Biological Contributes primary production Exhibits symblotic species interactions provides from predation grounds provides nursery areas provides refuge from predation provides decing grounds attructure surportate for attachment provides refuge from predation provides refuge from predation provides decing grounds attructure surportate for attachment provides refuge from predation provides refuge from predation provides refuge from predation provides from predation provid	Biological Contributes primary production Biological Contributes primary production Exhibits symbiotic species provides teeding grounds provides teeding grounds Provides teeding grounds Provides biodiversity Provides unreery areas Supports a complex trophic Supports a complex trophic Supports biomass production Physical Affects transport of Physical Supports biomass production Physical Supports biomass production Supports biomass production Supports a complex trophic Supports a complex trophic Supports a complex trophic Supports a complex trophic Supports biomass production Supports biomass production Physical Supports disapport of Physical Supports disapport of Meduces ereigy Chemical Modifies disaolved oxygen Chemical Modifies disaolved oxygen	maters to Monitor and abundance of: Contributes primary production Provides preding grounds	manufers to Monifor Contributes primary production	## Provides described from prediction Contributes primary production	integration and abundance of the provides the principle of the provides the provides the provides the provides the provides the provides the alter the provides t	## Sign of the control of the contr	Biological Contributes primary production Exhibits symbiotic species Contributes primary production Exhibits symbiotic species Provides retuge from predation Provides retuge from preda	Biological Contributes primary production Exhibits symbiotic species Exhibits symbiotic species Frovides tenge from predation Provides tenge from predation Provides tenge from predation Provides tenge from predation Provides tenge from predation Supports a complex trophic Supports a complex trophic	Biological Biological Biological Contributes primary production Browides tengorary floodwater temperature Chemical water duality Provides tengorary floodwater Supports a complex trophic subcorder and attractions Provides retuge from predation Supports a complex trophic subconders are subconding grounds Provides retuge from predation Prov	Biological Biological Contributes primary production Provides recording grounds Pr	## And a Bundance of the complete than produce that the complete that the complete than produce that the complete than the complete than the complete than the complete that the complete than the comp	## Conditions disposition, and abundance of the filter and survivorship of the filter and su	## Fig. 12 12 12 12 13 13 13 13

⁷ If the whole community is destroyed by disease or lack of seedling survival, all vegetation-related functions will be impaired

lacktriangleda= a pairing between a habitat characteristic and a measured parameter

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

Parameters to Monifor Parameters to Monifor Winder fevel fluctuation over time Parameters to Monifor Provides deciding grounds Provides relating throughing grounds Provides relating grounds Provides rela		_	_	_	_	_	_	_	π_	nctic -	onal	Functional Characteristics	ract	erist	iics -	_	_	_	_	_	_	_	_
Figure F	Parameters to Monitor	Biological								Supports a complex trophic structure	Supports biomass production	Supports biodiversity		Affects transport of suspended/dissolved material	Alters furbidity							Supports nutrient cycling	
Control depth	ydrological hysical																		Ī				Ī
• • • • • • • • • •	Fetch													•	*		_	* •			•		
Control of control o	PAR		•								•			•	•								
Control at sediment surface Cont	Secchi disc depth		*								•			*	*								
low rature	Shear force at sediment surface													•	•		•	•					
Temporature	Sheet flow													•	*	_	•	•		•	*	•	
Trash Trash Proporary water Proporary water wa	Temperature				_	•	•									•				•	*		
Trash Upstream land use Water column current velocity • <th< td=""><td>Temporary water</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>_</td><td>•</td><td></td><td></td><td>•</td><td>•</td><td>*</td><td></td></th<>	Temporary water															_	•			•	•	*	
Upstream land use Water column current velocity • • • • • • • • • • • • • • • • • • •	Trash					•								*	*								
Water column current velocity Water level fluctuation over time * * * * * * * * * * * * * * * * * * *	Upstream land use													*	*					•			
Water level fluctuation over time Part level fluctuation	Water column current velocity													*	*		•	_					
Pemical Chlorophyll concentration	Water level fluctuation over time				_	* •	•	•						*	*	_	•	•			*	•	
Chlorophyll concentration ◆ </td <td>hemical</td> <td></td> <td>I</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1</td>	hemical												I										1
Dissolved oxygen Pissolved oxygen<	Chlorophyll concentration		•			•					•			•	*					•	•	•	
♦ Nitrogen and phosphorus ♦ Image: PH Salinity (in tidal areas) ♦ Image: PH Im	Dissolved oxygen				_	•	•			*		*								•	*	*	
pH ♦	Nitrogen and phosphorus		•								•				*					•		*	
Salinity (in tidal areas) • <td>Н</td> <td></td> <td>•</td> <td></td> <td></td> <td></td>	Н																			•			
	Salinity (in tidal areas)	Ш				* •						•								*	•		

igoplus = a pairing between a habitat characteristic and a measured parameter

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

•	Supports nutrient cycling							•	•		•	•			•	*		•
•	Modifies dissolved oxygen									*		•			*		*	
٠	Modifies chemical water quality		•							*		•			*	*		*
٠	Chemical	I			-							I		I				
	Ке duces wave energy											•						
	Reduces erosion potential									*		•	*					
	Provides temporary floodwater storage						*		*	*	*							
•	Modifies water temperature						*			*								
3	Alters turbidity									*		•	*		*			
2	Affects transport of suspended/dissolved material						•			•		•	•		•			
	РһуѕісаІ	•			-			•										
5	Supports biodiversity						•			*	*		•		*		*	
3	Supports biomass production		•	,								•			*	*		
5	Supports a complex trophic structure														*			
5	Provides substrate for attachment						*			*		•						
•	Provides refuge from predation						*			*								
•	Provides nursery areas			•			*			*								
•	Provides feeding grounds			•			*			*					*			
•	Provides breeding grounds			•			•			*								
•	Produces wood																	
	Exhibits symbiotic species interactions																	
•	Contributes primary production		•	,														
-	Biological	ı										I						
	Parameters to Monitor	Hydrological (cont.)	Silicon		Soil/Sediment	Physical	Basin elevations	Bulk density	Depth of mottling	Geomorphology (slope, basin cross section)	Moisture levels and drainage	Sediment grain size (OM ⁸ /sand/silt/dav/gravel/cobble)	Sedimentation rate and quality	Chemical	Organic content in sediment	Pore water nitrogen and phosphorus	Pore water salinity (in tidal areas)	Redox potential

⁸ Organic matter

lacktriangleda= a pairing between a habitat characteristic and a measured parameter

Matrix C: Restoration Monitoring Parameters by Habitats

	-	-		i		Ha	bita	its					•	
Structural Parameters to Monitor	Water Column	Rock Bottom	Coral Reef	Oyster Reef	Soft Bottom	Kelp and Macroalgae	Rocky Shore	Soft Shore	SAV	Marsh	Mangroves	Deepwater Swamps	Riverine Forests	
Geographical														_
Acreage of habitat type	•	•	•	•	•	•	•	•	•	•	•	•	•	

Biological

Plants

Species, composition, and % cover of:

Algae		C	C	O		•	•	•	C		O		
Epiphytes			•		0	O	•		0		0		
Herbaceous vascular							•	•	•	•	0	O	O
Woody											•	•	•
Basal area												O	O
Canopy extent and structure						O			O		O	O	O
Interspersion of habitat types						•			0	•			
Phytoplankton diversity and abundance	O	O		0									
Plant height						0			O	O	O	O	O
Seedling survival						O			O	O	O	•	•
Stem density									O	O	O	•	•
Woody debris (root masses, stumps, logs)												O	O

Vertical relief			•	•										l
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Hydrological

Physical

Chlorophyll concentration	•				O			O					
PAR	0					•			•				
Secchi disc depth	0					•			•				
Shear force at sediment surface	0	O	O	O	C	O	O	O	0	O			
Sheet flow										O		•	
Temperature	0	0	•			•			0		0	0	0
Temporary water													0
- p y)
Upstream land use	•		0	0					0	0	•	•)
	• •	0	0	O	•	•	0		O	0	•	•	•

Chemical

Dissolved oxygen	•			0	0	O			O				
Groundwater indicator chemicals	O								O	0			0
Nitrogen and phosphorus	O		O	O	O				0	0	0		0
pH	O			O		0				0			
Salinity (in tidal areas)	•	•		•	•	O	0	O	•	•	•	0	O
Silicon	0												
Toxics	O	O	O	O	O	0	O	O	O	O	O	O	0

Soil/Sediment

Physical

Basin elevations	O	O		O		O	C	C	C		C	0
Bulk density									O		O	0
Depth of mottling												O
Geomorphology (slope, basin cross section)	•	•	•	•	•	•	•	•	•	•	•	•
Moisture levels and drainage											C	O

- Represents a parameter that is recommended for measurement in most restoration monitoring projects
- O Represents a parameter that might be useful to monitor depending on the goals of the project but is not considered critical for all monitoring programs

Matrix C: Restoration Monitoring Parameters by Habitats (cont.)

	Habitats													
Structural Parameters to Monitor (cont.)	Water Column	Rock Bottom	Coral Reef	Oyster Reef	Soft Bottom	Kelp and Macroalgae	Rocky Shore	Soft Shore	SAV	Marsh	Mangroves	Deepwater Swamps	Riverine Forests	
Soil/Sediment									•					
Physical														
Organic content		0		0	•	0	O	•	0	•	O	0	0	
Percent sand, silt, and clay		O			•	O	•	•	O	O	O	0	0	
Sedimentation rate and quality		O	O	O	•		O	0	O	•	0	O	O	
Chemical														
Pore water nitrogen and phosphorus		O		O	O	0		O	O	O			0	
Pore water salinity (in tidal areas)										•		0		
Redox potential									0	O		0		

Functional Parameters to Monitor

Acreage of habitat types	•	•	•	•	•	•	•	•	•	•	•	•	•

Biological

Plants

Species, composition, and % cover of:

Algae		O	O	O		•	C	C	O		O		
Epiphytes			•		O	C	C		O		O		
Herbaceous vascular							0	0	•	•	0	0	O
Invasives		O			C		O	0	O	O	O	0	O
Woody											•	•	•
Basal area												0	O
Canopy extent and structure						0			O			0	O
Interspersion of habitat types	O	O	O	O	O	O	C	C	O	C	O	O	O
Litter fall											O	0	0
Mast/seed production													0
Nutrient levels in algal tissues (N and P)	O		0										
Phytoplankton diversity and abundance	O	O		O									
Plant health (herbivory damage, disease)		O			O	0	O	0	O	O	O	0	0
Plant height						0			O	O		0	0
Plant weight (above/ below ground parts)						0			0	0			
Rate of canopy closure						O			O		O	O	O
Seedling survival						O			O	O	O	•	•
Stem density			,			0	,	,	0	0		0	0
Woody debris (root masses, stumps, logs)			·				·	·				O	O

Animals

Species, composition, and abundance of:

Amphibians										O	O		O
Birds		O		O		O	•	•	O	O	•	0	0
Fish	O	•	•	O	O	O	O	O	O	O	O	0	
Invasives	O	O	O	•	O		O	O	O	O		0	
Invertebrate	0	•	•	0	•	0	•	•	0	0	O	0	O
Mammals										0	0	0	0
Reptiles										O	O	O	O

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Matrix C: Restoration Monitoring Parameters by Habitats (cont.)

			Ī	-	Ī	На	abita	its	-		ī	•	
Functional Parameters to Monitor (cont.)	Water Column	Rock Bottom	Coral Reef	Oyster Reef	Soft Bottom	Kelp and Macroalgae	Rocky Shore	Soft Shore	SAV	Marsh	Mangroves	Deepwater Swamps	Riverine Forests
Biological (cont.) Animals (cont.)												_	
Animal health (disease)				•									
Coral growth rate			0										
Coral recruitment, and survival			O		_								
Fecal coliforms	0		_		0		_						
Grazer density			0	_			O						
Vertical relief of reef	1		•	•									
Hydrological Physical													
Fetch	O						O	O	O	O	O	O	
PAR				•		•			•	O	O	0	O
Secchi disc depth	O			•		•			•	O	O	O	O
Shear force at sediment surface					O			O	O	C			
Sheet flow										C		O	O
Temperature									0			0	O
Temporary water													•
Trash	0	O	0	O	0	0	0	O	0	0	0	0	O
Upstream land use	•		O	O					O	O		•	•
Water column current velocity	0		O	O		0	O		O		0	O	
Water level fluctuation over time	•	•		•		0	•	•	•	•	•	•	•
Chemical													
Chlorophyll concentration	•				0			0					
Dissolved oxygen	•			0	0	0			0	_	_	_	
Nitrogen and phosphorus	0			O	O				0	0	O	0	O
Salinity (in tidal areas)	0								0	0		0	
Silicon Toxics	0	0	0	0	0	0	0	0	0	0	0	0	0
Soil/Sediment Physical Basin elevations			O	0	0				O	0		0	
Bulk density										0		0	0
Depth of mottling													9
Geomorphology (slope, basin cross section)		•	•	•	•	•	•	•	•	•	•	•	•
Moisture levels and drainage												0	•
Sediment grain size		_			_	_	_	_	_	_			
(OM/sand/silt/clay/gravel/cobble)		0	0	0	•	0	0	0	0	0	0	0	0
Sedimentation rate and quality		O	O	C	•		O	O	O	O	O	O	0
Trash		O	O	O	O	O	O	O	O	O	C	C	O
Chemical													
Organic content in sediment					0			O	O	O		O	•
Pore water nitrogen and phosphorus										O		O	•
Pore water salinity (in tidal areas)										0		O	
Redox potential										0		0	O

[•] Represents a parameter that is recommended for measurement in most restoration monitoring projects

O Represents a parameter that might be useful to monitor depending on the goals of the project but is not considered critical for all monitoring programs